

## CLINICAL SCIENCE

## Visual performance after interface haemorrhage during laser in situ keratomileusis

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**Aim:** To study the visual performance in eyes with interface haemorrhage during laser assisted in situ keratomileusis (LASIK).

**Methods:** Case records of 20 patients, who had bleeding from the limbal vessels in one eye during LASIK (group 1) and uncomplicated surgery in the fellow eye (group 2) were studied. The parameters evaluated were uncorrected visual acuity (UCVA) best corrected visual acuity (BCVA), spherical equivalent of refraction (SEQ), contrast sensitivity, and glare acuity preoperatively and at 1, 3, and 6 months postoperatively.

**Results:** The mean preoperative SEQ in group 1 and 2 eyes was  $-5.79$  (2.3) D and  $-5.27$  (1.68) D, respectively. The mean decimal UCVA at 6 months after LASIK in group 1 and 2 eyes were 0.6 (0.2) and 1.0 respectively ( $p < 0.001$ ). The mean decimal BCVA at 1 week after LASIK in group 1 and 2 eyes were 0.89 (0.04) and 1.0 respectively ( $p < 0.05$ ). However, all eyes had a BCVA of 6/6 at 1, 3, and 6 months after LASIK. The mean contrast sensitivity values preoperatively in group 1 and 2 eyes were 161.3 (8.7) and 172 (68.2) respectively. There was a significant decrease in group 1 at 6 months (102 (60.5) ( $p < 0.01$ )) compared to group 2. The decimal glare acuity preoperatively in group 1 and 2 eyes was 0.95 (0.11) and 0.89 (0.12), respectively. It decreased significantly in group 1 (0.7) (0.1 ( $p < 0.01$ )) compared to group 2 at the 6 month follow up.

**Conclusion:** Occurrence of intraoperative interface haemorrhage may affect the visual performance following LASIK surgery.

Laser in situ keratomileusis (LASIK) has now become the most commonly performed refractive procedure for myopia and astigmatism. However, it is not free from complications that can occur during and after the surgery. These complications can be intraoperative and postoperative. Intraoperative bleeding from limbal blood vessels is a known adverse event during the LASIK.<sup>1</sup>

Visual acuity is a crude measure of visual performance. This is usually measured by high contrast targets such as Snellen's chart. However, in everyday life such high contrast targets are rarely encountered, and patients who score well on Snellen visual acuity charts may complain of poor vision in everyday situations.<sup>2</sup> To the best of our knowledge, there is no study showing influence of contrast sensitivity and glare acuity in eyes, in which intraoperatively corneal bleeding occurred. Hence, we undertook this retrospective case series study to evaluate the visual performance in eyes that had corneal bleeding during LASIK procedure.

## SUBJECTS AND METHODS

Patient charts for all cases of LASIK procedures for myopia performed from March 1999 to June 2001, at the Rajendra Prasad Centre for Ophthalmic Sciences by experienced surgeons were retrospectively reviewed. Eyes with interface haemorrhage were identified. Twenty patients who underwent LASIK for myopia and had bleeding from limbal vessels in one of their eyes (group 1,  $n = 20$ ) (14 right eyes and six left eyes) and uneventful surgery in the fellow eye (group 2,  $n = 20$ ) were evaluated by reviewing the charts. Inclusion criteria for LASIK at our centre are age  $> 18$  years, stable refraction for at least 1 year and a best corrected visual acuity (BCVA) of 6/9 or better. Patients with keratoconus, active inflammatory disease, ocular surface disease, and previous ocular surgery were excluded. Patients with rigid gas permeable contact lenses discontinued their lenses for 4 weeks and those with soft lenses for 2 weeks

prior to LASIK. Informed written consent was obtained from all the patients.

Before and after LASIK patients underwent comprehensive ocular examination which included slit lamp biomicroscopy, uncorrected and best corrected visual acuity (UCVA and BCVA) using Snellen visual acuity charts, manifest and cycloplegic refraction (under 1% tropicamide), contrast sensitivity, glare acuity, pupil diameter was measured with Humphrey corneal topography system (Carl Zeiss, Inc, Dublin, CA, USA), direct and indirect ophthalmoscopy, corneal topography and pachymetry with Orbscan slit scanning corneal topography/pachymetry system (Orbtek Inc, Salt Lake City, UT, USA).

Contrast sensitivity was measured with Cambridge low contrast gratings (Clement Clarke, Harlow, UK). The test chart was hung vertically with adequate illumination. Each eye was tested separately with patient at a distance of 6 metres with best refractive correction. The optimal illuminance was chosen such that luminance of the non-grating plate in the demonstration pair was 100  $\text{cd/m}^2$ . The test had 12 pairs of plates; the first pair served as demonstration. The patient was asked to choose the page, which had stripes (top or bottom). Guessing was allowed if the patient was not able to see the stripes. The next 10 plates were numbered 1–10 and were used as 10 test stimuli. The plates were shown in sequence until the patient failed to make a response even on guessing. The number of test stimulus on which the error was made was noted and the second series of the test was begun after going back four stimuli. This was continued for four series and the scores of all the four series were summed up and were converted to contrast sensitivity values. The gratings in the chart are designed to measure the contrast at one spatial frequency only. At 6 metres each plate subtends  $2 \times 2$  degrees and contains eight cycles. The gratings therefore have a spatial frequency of 4 cycles/degree. These gratings have a square wave

**Table 1** Visual performance after LASIK in two groups

Variable	Group	Preoperative (1)	Postoperative				Two way ANOVA	Multiple range test
			1 week (2)	1 month (3)	3 months (4)	6 months (5)		
SEQ (diopters)	Group 1	-5.8±2.3	-0.02±0.08	-0.34±0.2	-0.5±0.3	-0.5±0.4	F=61.97 p<0.0001	1vs2:a, 1vs3:a, 1vs4:a, 1vs5:a
	Group 2	-5.3±1.7	0	-0.02±0.08	0.06±0.34	-0.02±0.08	F=98.77 p<0.0001	1vs2:a, 1vs3:a, 1vs4:a, 1vs5:a
	p value	0.18	0.34	0.003	0.002	0.001		
Decimal UCVA	Group 1	0.1±0.09	0.85±0.13	0.7±0.1	0.5±0.4	0.6±0.2	F=21.73 p<0.0001	1vs2:a, 1vs3:a, 1vs5:a
	Group 2	0.11±0.09	0.9±0.3	0.97±0.1	0.97±0.1	1	F=79.09 p<0.0001	1vs2:a, 1vs3:a, 1vs4:a, 1vs5:a
	p value	0.34	0.5	0.0006	0.0056	0.0001		
Contrast sensitivity value	Group 1	161±80.7	84.6±59.7	93±58.9	97.7±61.3	102±60.5	F=36.71 p<0.0001	1vs2:b, 1vs3:a, 1vs4:b, 1vs5:b
	Group 2	172±68.1	127±61	142±59.4	151±60.3	162±63.9	F=26.3 p<0.0001	1vs2:a, 1vs3:b, 1vs4:c,
	p value	0.27	0.001	0.0000	0.0001	0.0000		
Decimal glare acuity	Group 1	0.95±0.1	0.54±0.1	0.6±0.1	0.63±0.1	0.7±0.1	F=42.7 p<0.0001	1vs2:a, 1vs3:a, 1vs4:b, 1vs5:b
	Group 2	0.89±0.1	0.67±0.1	0.7±0.1	0.83±0.1	0.9±0.1	F=16.6 p<0.0001	1vs2:b
	p value	0.08	0.004	0.0005	0.0007	0.0006		

p<0.001:a, p<0.01:b, p<0.05:c, Group 1: Eyes with intraoperative bleeding, Group 2: Eyes with uneventful LASIK, LASIK = laser in situ keratomileusis.

luminance profile, the sensitivity of which is higher than sinusoidal ones.

Glare acuity was tested using IRAS-GT glare tester (Randwal, Southbridge, MA, USA). The interference acuity test was done to determine the retinal threshold acuity. The acuity was reset to 20/800 and the field size to 8 degrees. The glare lights were switched on and the patient saw four spotlights of equal intensity surrounding the interference fringe pattern. The reflexes were focused on the patient's pupil. The corneal reflex from the four glare sources came to a focus at the same point as the slit sources. The intensity was set at "Lo" and the procedure for acuity threshold repeated. A difference of retinal acuity threshold reading of two lines or more with or without glare sources was taken as significant impairment.

Preoperatively two drops of 0.3% ciprofloxacin and 0.5% oxybuprocaine (proparacaine) hydrochloride were instilled before surgery 15 minutes apart. All LASIK procedures were performed with the patient under topical anaesthesia (oxybuprocaine 0.5%) using the Bausch & Lomb Technolas 217C (Bausch & Lomb Technolas GmbH, Dornach, Germany) LASIK machine. As a routine, simultaneous bilateral LASIK is performed at our centre (right eye followed by the left). In all eyes, Hansatome microkeratome (Bausch & Lomb Surgicals, Munich, Germany) with 180 µm plate and 9.5 mm suction ring was used to create a superior hinged flap. In patients who had bleeding from limbal vessels in their right eye, 8.5 suction ring was used for the other eye. The bleeding was controlled by placing a methylcellulose soaked sponge (Surgical Spears; Merocel Corp, Mystic, CT, USA) with phenylephrine hydrochloride (Neo-Synephrine 2.5%) for approximately 20 seconds before the flap was retracted. After the laser treatment, the bed

was carefully wiped to remove excess red blood cells and other intravascular contents from the interface. A suction speculum was used, when the repositioned posterior surface of the flap was irrigated with balanced salt solution (BSS; Alcon, Fort Worth, TX, USA) and flap was aligned. An adherence time of 3 minutes was observed. One drop of 0.3% ciprofloxacin eye drops was instilled at the completion of the procedure.

Postoperatively, patients received ciprofloxacin 0.3% and fluorometholone 0.1% four times a day for 1 week. Artificial tears were given six to eight times a day. Nine out of 20 eyes in which interface haemorrhage occurred had mild interface haze at 1 week after LASIK. In these eyes, 0.1% fluorometholone four times daily was continued until the interface haze resolved. Interface haze resolved in all eyes by 2 weeks postoperatively, following which the topical steroids were tapered. Patients were asked to follow up at day 1, 1 week, 1 month, 3 months, 6 months, and 1 year after LASIK or more frequently, if required.

### Statistical analysis

Data were managed on an Excel spreadsheet. All the entries were checked for any possible error. All the variables in the study were quantitative; therefore, after confirming for approximate normality, these variables were summarised by mean and standard deviation separately for both complications and no-complications groups. As the study subjects were followed up and measurements were made at the fixed time points in both groups, therefore, to compare the mean values of each study variable we used randomised block analysis of variance, followed by Bonferroni multiple comparison, if required. Also, we used Student's *t* test to compare the mean values of study variables at baseline and following surgery

between both groups. For data analysis, STATA 7.0 (intercooled version) and SPSS 8.0 statistical softwares were used. In this study, all the tests used were two tailed and  $p < 0.05$  has been considered as statistically significant.

## RESULTS

Out of total 20 patients, there were 14 females and six males with a mean age of 23.7 (SD 4.2) years (range 18–27 years). The mean preoperative spherical equivalent refraction in eyes with interface haemorrhage was  $-5.8$  (2.3) dioptres (D), which significantly decreased to  $-0.02$  (0.08) D at 1 week post LASIK ( $p < 0.001$ ). At 3 months post LASIK SEQ was  $-0.5$  (0.3) D, and this increase was statistically significant as compared to 1 week following LASIK ( $p < 0.01$ ). In eyes with uneventful LASIK (group 2), the mean preoperative SEQ was  $-5.3$  (1.7) D, which significantly decreased to  $-0.02$  (0.08) at 1 month following LASIK ( $p < 0.0001$ ) (Table 1).

The mean (SD) preoperative decimal UCVA in group 1 eyes was 0.104 (0.09), it significantly improved to 0.85 (0.13) at 1 week post LASIK ( $p < 0.001$ ). Further change at 1, 3, and 6 months compared to 1 week post-LASIK was not significant. In group 2 eyes, the mean preoperative decimal UCVA was 0.1 (0.09), which significantly improved to 0.9 (0.3) at 1 week post-LASIK ( $p < 0.0001$ ). Further change in UCVA was not statistically significant compared to postoperatively, 1 week. The decimal UCVA at 6 months after LASIK in group 1 and 2 eyes were 0.6 (0.2) and 1.0 respectively, this difference in UCVA between the two groups was statistically significant ( $p < 0.0001$ ).

The mean decimal BCVA at 1 week after LASIK in group 1 and 2 eyes were 0.89 (0.04) and 1.0 respectively, the difference between the groups was statistically significant ( $p < 0.05$ ). However, all eyes had a BCVA of 6/6 at 1, 3, and 6 months after LASIK and there was no significant difference between the two groups.

The mean (SD) contrast sensitivity values preoperatively in group 1 was 161.0 (80.7), which decreased to 84.6 (59.7) at 1 week following LASIK ( $p < 0.01$ ). Contrast sensitivity improved at 1, 3, and 6 months compared to 1 week following LASIK; however, this was statistically not significant. In group 2, the mean contrast sensitivity before LASIK was 172 (68.1), which decreased to 127 (61.0) at 1 week following LASIK ( $p < 0.001$ ). This contrast sensitivity significantly improved to 162 (63.9) at 6 months, compared to 1 week following LASIK ( $p < 0.01$ ).

Decimal glare acuity in group 1 eyes before LASIK was 0.95 (0.1), it significantly decreased to 0.54 (0.1) at 1 week postoperatively ( $p < 0.001$ ). Further improvement at 1, 3, and 6 months was not significant compared to 1 week postoperatively. In group 2, the mean (SD) preoperative decimal glare acuity was 0.89 (0.1) it decreased to 0.67 (0.1) at postoperative 1 week ( $p < 0.01$ ). This glare acuity significantly improved to 0.9 (0.1) at 6 months compared to 1 week following LASIK ( $p < 0.01$ ).

The mean (SD) attempted ablation depth and zone diameter in group 1 eyes were 99.6 (20.1)  $\mu\text{m}$  and 5.6 (0.6) mm respectively. In group 2 eyes, attempted ablation depth and zone diameter were 96 (22.2)  $\mu\text{m}$  and 5.7 (0.4) mm respectively. The mean suction ring size used in group 1 and 2 eyes were 9.2 (0.15) mm and 8.8 (0.15) mm respectively. The average pupil diameter was 3.8 (0.45) mm (range 3–4.58 mm) for both the groups, with no statistically significant difference between the two groups.

## DISCUSSION

Bleeding from the perilimbal corneal vessels has been reported as the most frequent complication of LASIK performed by an experienced surgeon.<sup>1–3</sup> However, little information is available about its effect on the contrast sensitivity

and glare acuity. Contrast sensitivity testing expands on the information gained from Snellen acuity testing by determining the resolving power of the eye over a spectrum of target sizes.

We found that intraoperative bleeding was more frequent in eyes with larger diameter flaps, which is similar to those observed by MacRae and associates.<sup>4</sup> Now we are routinely using a smaller suction ring, in cases where micropannus haemorrhage is a possibility. On the other hand, if intraoperative perilimbal bleeding has led to interface haze, the topical steroid drops are continued in the same frequency until the haze has resolved or for at least 2 weeks postoperatively, whichever is earlier.

In our study, eyes with intraoperative bleeding (group 1) had significant regression as compared to group 2 eyes. Perilimbal vessel leakage may be a cause of post-LASIK sterile interface keratitis.<sup>4</sup> Stronger wound healing response resulting in greater corneal remodelling may be a cause of regression in these eyes.

Perej-Santonja and colleagues<sup>5</sup> have found that contrast sensitivity after LASIK for intermediate and low spatial frequencies decreases at 1 month after surgery and these values returned to preoperative values at 3 months. In our study, eyes with intraoperative bleeding had more decrease in contrast sensitivity following LASIK with no significant improvement at 3 months, compared to eyes with uneventful LASIK. Similarly, glare acuity decreased after LASIK in both the groups. Eyes with intraoperative bleeding had no significant improvement over the follow up period, while eyes with uneventful LASIK had significant improvement from 1 week post-LASIK to 6 months. This may be attributed to irregular ablation and healing resulting in more peripheral aberrations in these eyes.

Most of our patients did not complain of subjective decrease in contrast sensitivity and glare acuity, hence the clinical significance of these findings needs to be prospectively evaluated on the basis of objective questionnaire. Measuring of contrast sensitivity at a single spatial frequency may be a limiting factor in our study. Our understanding of contrast sensitivity and glare acuity in these eyes can be enhanced by studying a larger number of subjects, over a longer period of follow up, testing contrast sensitivity over a wider range of spatial frequencies and, evaluating the role of pupillary diameter in mesopic conditions.

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